JPSS MICROWAVE SOUNDER (JMS)

INSTRUMENT PERFORMANCE AND OPERATIONS SPECIFICATION (IPOS)

March 23, 2011

Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

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GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

Performance and Operations Specification

for the JPSS Microwave Sounder Instrument

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1.0 SCOPE

1.1 IDENTIFICATION

This Instrument Performance and Operations Specification sets forth the requirements for the JPSS Microwave Sounder (JMS).

1.2 SENSOR OVERVIEW

The purpose of JMS is to collect microwave radiance data that when combined with the CrIS data will permit the calculation of atmospheric temperature and water vapor profiles.

1.3 DOCUMENT OVERVIEW

This document contains all performance requirements for the JMS sensor. This document and the Joint Polar Satellite System General Instrument Interface Document (GIID) (GSFC 472-00018 rev -, 12/15/2010), define all sensor/spacecraft interfaces for the JMS. The term “TBD” applied to a missing requirement means that the contractor should determine the missing requirement in coordination with the government. The term “TBS”, means that the government will supply the missing information in the course of the contract. The term “TBR” means that the requirement is subject to review for appropriateness by the contractor or the government. The government may change “TBR” requirements in the course of the contract.

Appendix A defines the acronyms and abbreviations used throughout the document.

1.3.1 CONFLICTS

1.3.1.1

In the event of conflict between the referenced documents and the contents of this specification, the contents of this specification shall be the superseding requirements.

1.3.1.2

In the event of a conflict involving the external interface requirements, or in the event of any other unresolved conflict, the contracting officer shall determine the order of precedence.

2.0 APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is TBR.

2.1.1 SPECIFICATIONS

2.1.2 STANDARDS

2.1.3 OTHER:

GSFC 429-00-06-02	JMS Statement of Work
GSFC 472-00026	JPSS Instrument Mission Assurance Requirements rev -, 1/13/2011
GSFC 472-00018	JPSS General Instrument Interface Document (GIID) rev -, 12/15/2010

2.2 NON-GOVERNMENT DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1.

2.2.1 STANDARDS:

CCSDS 701.0-B-2 Nov. 1992	<u>CCSDS Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification</u>

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because various parts of the specification refer to them.

2.3.1 Specifications:

2.3.2 Standards:

2.3.3 Other:

3.0 SENSOR REQUIREMENTS

3.1 DEFINITION

3.1.1 JMS Description

- The JMS shall be a total power microwave radiometer system.
- The JMS shall consist of one instrument.
- The JMS shall be compatible with both the JPSS satellite architectures.
- On-orbit calibration is required in all channels.
- The JMS shall contain a diagnostic capability that produces data for use in ground analysis of individual radiometric channel performance.

3.1.2 Specification Tree

Figure 3-1 depicts a partial specification tree for the JPSS System.

3.1.3 Top-Level JMS Functions

The JMS instrument shall perform the following functions.

- Scene radiance measurement.
- On-orbit calibration.
- On-orbit monitoring of calibration sources and instrument response changes.
- Acquisition of sensor health and status data.
- Generation of data streams containing scene radiance, calibration, monitoring, health and status data.
- Reception of command and control data.
- Accepting S/W uploads from the S/C
- Accepting calibration tables from the S/C

3.1.4 JMS Modes

The JMS shall implement the following modes as a minimum.

- OFF Mode
- OPERATIONAL Mode
- DIAGNOSTIC Mode
- SAFE-HOLD Mode
- SURVIVAL Mode

3.1.5 JMS MODES DESCRIPTION

3.1.5.1 Sensor-Off Mode

In the Sensor-Off mode, no power is supplied to the sensor.

3.1.5.2 Operational Mode

3.1.5.2.1
The sensor shall be in full functional configuration during the Operational Mode.

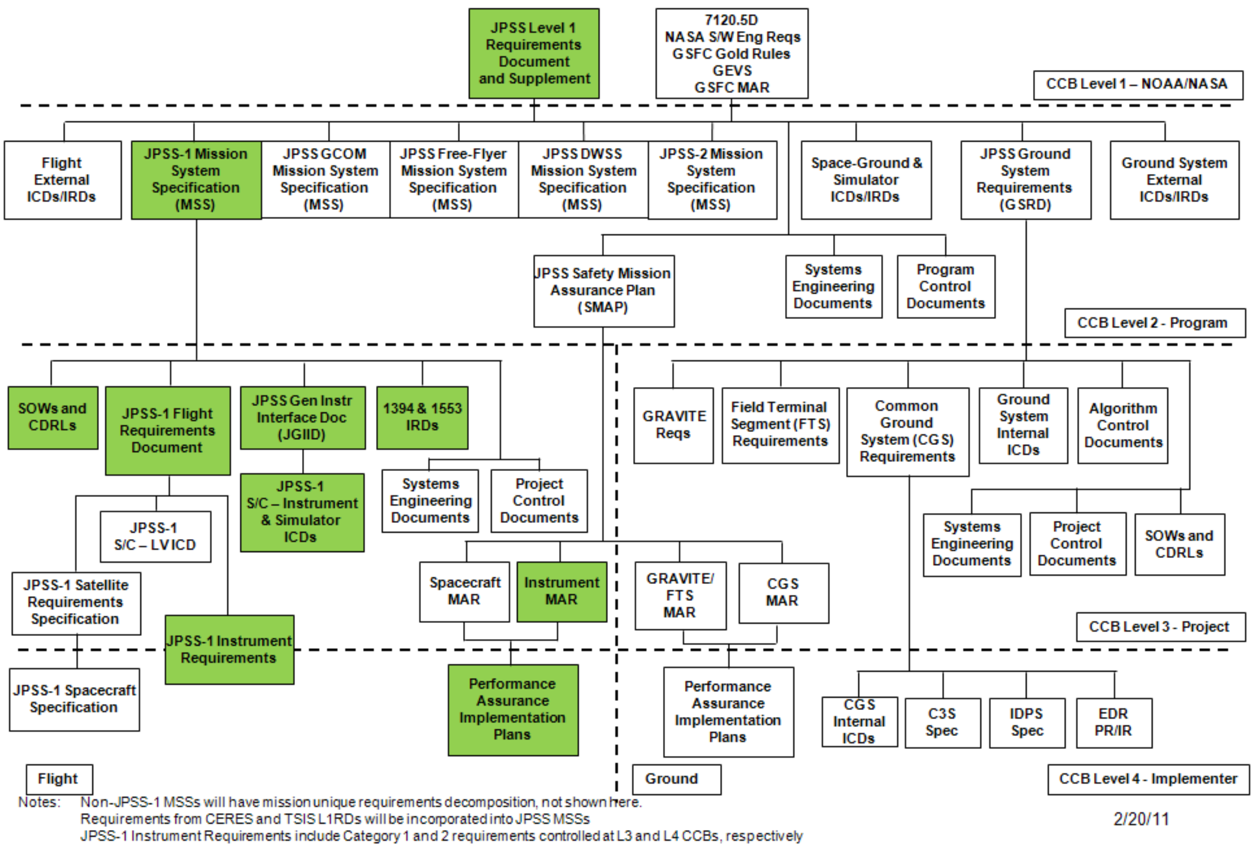

Figure 3-1 Notional Specification Tree for the JPSS Program

3.1.5.2.2
Mission and housekeeping data shall be collected.

3.1.5.2.3
Calibrations shall be performed during regular operations.

3.1.5.3 Sensor Diagnostic Mode

3.1.5.3.1

Diagnostic mode shall include trouble shooting and software updates.

3.1.5.3.2

The JMS shall be capable of stopping at each scan position and providing radiometric data and status /engineering telemetry.

3.1.5.4 Sensor Safe-Hold Mode

In the Safe Hold mode, health and status data shall be collected and transmitted. Mission and calibration data are not collected. In Safe Hold mode, most components are turned off. During Safe Mode, no survival heater power is needed unless the spacecraft's JMS Cold Plate temperature drops below –20º C.

3.1.5.4.1

The Safe Hold Mode shall be a power conservation mode. The Sensor shall accept a command in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. A power subsystem anomaly is such an event.

3.1.5.4.2

In response to a spacecraft C&DH-issued power conservation, re-configuration commands to the sensors via the data bus, the JMS shall place itself into a safe configuration. The return to the Normal Operations Mode requires ground intervention.

3.1.5.5 Sensor Survival Mode

In the Survival Mode, the instrument operational power shall be off, with survival heaters activated.

3.1.6 SENSOR SPECIFIC MODES

3.1.6.1

The JMS ICDs shall define sensor modes.

3.1.6.2

The JMS shall adhere to the Safe-Hold Mode re-configuration commands defined in the ICD.

3.1.7 OPERATIONAL AND ORGANIZATIONAL CONCEPT

3.1.7.1 Launch Operations Concept

3.1.7.1.1 Pre-Launch

The satellite, on which the JMS is attached, will be transported to the launch base where final vehicle preparations and checkout shall be accomplished. Final inter-segment and launch system verification tests shall be accomplished prior to launch.

3.1.7.1.2 Launch and Injection

During launch and injection to the operational orbit, the JMS shall be turned off in order to provide protection from the launch and injection environments or to comply with other specified requirements. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments will be initiated by stored command. Spacecraft telemetry to monitor vehicle status will be provided during launch and injection. Transmission of launch vehicle telemetry will satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations will be used to the extent practicable during the injection phase. Early orbit check-out will be conducted at the JPSS primary Satellite Operations Control Center (SOCC) in Suitland, MD for the JPSS JMS.

3.1.7.2 On-Orbit Operational Concept

The JPSS satellite will operate in a near-polar circular, sun-synchronous orbit with a nominal 1330 local descending node at an altitude of approximately 824-km.

The sun Beta angle, β, is the angle between the solar vector (i.e., the spacecraft-sun line) and the orbit plane. For instrument thermal design purposes, the range of β for the JPSS missions is $\pm$ 90 degrees. The satellite will maintain the sun on the appropriate side of the spacecraft to meet the 'all beta' requirement.

3.1.7.2.1

The JMS instrument design shall be such that data acquisition and necessary calibrations can be completed if the satellite is flown with any equatorial crossing time (ascending or descending). Selection of a specific orbital time of day, for JPSS satellites, will be made 60 days before launch.

3.1.7.2.2

JMS shall meet its Specified performance for the orbit in 3.1.7.2.

3.1.7.2.2.1 On-Orbit Tests

The initial on-orbit period is devoted to a complete spacecraft checkout and the calibration and performance verifications of the payload. The spacecraft and payload performance verification tests may be repeated at appropriate times during the operational phase of the mission.

3.1.7.2.2.2 On-Orbit Operations

In normal mode, the sensor shall be capable of operating continuously without additional commands.

3.1.8 MISSIONS

The mission of the JMS is to collect specialized data to permit the calculation of atmospheric temperature and water vapor profiles.

3.2 SENSOR CHARACTERISTICS

3.2.1 PERFORMANCE REQUIREMENTS

3.2.1.1 Channels

JMS shall meet the characteristics defined in Table 3-1.

3.2.1.2 Beam Scanning

3.2.1.2.1
Each channel of the JMS is considered to form a beam.

Table 3-1 JMS Channel Characteristics

Channel	CENTER FREQUENCY (GHz)	MAXIMUM BANDWIDTH (GHz)	CENTER FREQUENCY STABILITY (MHz)	TEMPERATURE SENSITIVITY (K) NEΔT	CALIBRATION ACCURACY (K)	STATIC BEAM WIDTH θ_B (degrees)	QUASI POLARIZATION	CHARACTERIZATION AT NADIR (REFERENCE ONLY)
1	23.8	0.27	10	0.9	2.0	5.2	QV	window-water vapor 100 mm
2	31.4	0.18	10	0.9	2.0	5.2	QV	window-water vapor 500 mm
3	50.3	0.18	10	1.20	1.5	2.2	QH	window-surface emissivity
4	51.76	0.40	5	0.75	1.5	2.2	QH	window-surface emissivity
5	52.8	0.40	5	0.75	1.5	2.2	QH	surface air
6	53.596±0.115	0.17	5	0.75	1.5	2.2	QH	4 km ~ 700 mb
7	54.40	0.40	5	0.75	1.5	2.2	QH	9 km ~ 400 mb
8	54.94	0.40	10	0.75	1.5	2.2	QH	11 km ~250 mb
9	55.50	0.33	10	0.75	1.5	2.2	QH	13 km ~ 180 mb
10	57.290344	0.33	.5	0.75	1.5	2.2	QH	17 km ~ 90 mb

Channel	CENTER FREQUENCY (GHz)	MAXIMUM BANDWIDTH (GHz)	CENTER FREQUENCY STABILITY (MHz)	TEMPERATURE SENSITIVITY (K) NEΔT	CALIBRATION ACCURACY (K)	STATIC BEAM WIDTH θ_B (degrees)	QUASI POLARIZATION	CHARACTERIZATION AT NADIR (REFERENCE ONLY)
11	57.290344±0.217	0.078	.5	1.20	1.5	2.2	QH	19 km ~ 50 mb
12	57.290344±0.3222 ±0.048	0.036	1.2	1.20	1.5	2.2	QH	25 km ~ 25 mb
13	57.290344±0.3222 ±0.022	0.016	1.6	1.50	1.5	2.2	QH	29 km ~ 10 mb
14	57.290344±0.3222 ±0.010	0.008	.5	2.40	1.5	2.2	QH	32 km ~ 6 mb
15	57.290344±0.3222 ±0.0045	0.003	.5	3.60	1.5	2.2	QH	37 km ~ 3 mb
16	87-91.9	2.0	200	.5	2.0	2.2	QV	Window H_2O 150 mm
17	164-167[1]	3.0	200	0.6	2.0	1.1	QH	H_2O 18 mm
18	183.31±7	2.0	100	0.8	2.0	1.1	QH	H_2O 8 mm
19	183.31±4.5	2.0	100	0.8	2.0	1.1	QH	H_2O 4.5 mm
20	183.31±3	1.0	50	0.8	2.0	1.1	QH	H_2O 2.5 mm
21	183.31±1.8	1.0	50	0.8	2.0	1.1	QH	H_2O 1.2 mm
22	183.31±1	0.5	30	0.9	2.0	1.1	QH	H_2O 0.5 mm

NOTE: 1 Maximum allowable bandwidth

3.2.1.2.2
All main beam axes of the JMS shall be coincidental, i.e., they shall be pointing in the same direction (subject to the pointing accuracy requirements of 3.2.1.6) at the same time for any given beam position.

NOTE: In the following sections, if only one beam is discussed it is inferred to represent all beams.

3.2.1.3 Cross-Track Scan

3.2.1.3.1
The JMS beams shall scan cross-track to the satellite motion.

3.2.1.3.2
The scan direction shall be from sun to anti-sun.

3.2.1.4 Scan Motion and Pattern

3.2.1.4.1
The total scan period shall be 8/3 seconds.

3.2.1.4.2
The JMS shall use the “integrate-while-scan”-type scan method.

3.2.1.4.3
During each scan period the instrument shall gather data from a minimum of 104 beam positions, each datum to be called a “sample,” obtained from a cell corresponding to that beam position

NOTE: The term “ Beam Position” means the position of a “Beam-Center,” which is defined as the position of the beam (axis or center) at the mid-point of the integration time. The term cell refers to the segment from the start to the end of the integration time.

3.2.1.4.4
Each cell shall have the same integration time.

3.2.1.4.5
The JMS beams total scan during the earth-viewing sector shall be a total of 105.45° between the center of scan position 1 and the center of scan position 96.

3.2.1.4.6
There shall be a total of 96 Earth-viewing beam positions.

3.2.1.4.7
The 96 beam positions shall be called cell numbers 1 through 96, from sun to anti-sun direction.

3.2.1.4.8
There shall be 48 Earth-viewing cells on either side of nadir.

3.2.1.4.9
The beam center position of each cell shall be separated from the adjacent cell along the scan direction by 1.11°.

3.2.1.4.10
There shall be a non-cumulative beam center position to center position tolerance of ±0.05°.

3.2.1.4.11
There shall be four beam position groups that are selectable by command to provide a cold (space look) calibration position.

3.2.1.4.12
The primary cold calibration beam position group shall nominally be at 6.66° below the anti-sun normal toward nadir in the scan plane.

3.2.1.4.13
The three "alternate" cold calibration position groups shall nominally be at 8.33°, 10.00° and 13.33° below the anti-sun normal toward nadir in the scan plane.

3.2.1.4.14
There shall be four samples collected from the internal hot calibration position.

3.2.1.4.15
There shall be provisions to command and park the scanner at an Earth-view, cold-space calibration or hot-calibration scan position.

3.2.1.5 Scan Synchronization

3.2.1.5.1
The JMS shall use the timing signal it receives from the spacecraft via RS-422 every 8 seconds (± 1 ms) to synchronize its scan start with the Cross Track Infrared Sounder (CrIS). In the event the signal is not available, JMS shall continue its normal scan sequence until a synchronization signal is detected.

3.2.1.6 Beam-Pointing Accuracy

3.2.1.6.1
For each position, the beam-pointing accuracy shall be better than :

- ± 0.10 degrees for the 1.1 degrees beamwidth channels
- ± 0.15 degrees for the 2.2 degrees beamwidth channels
- ± 0.30 degrees for the 5.2 degrees beamwidth channels

The beam pointing knowledge shall be better than ± 0.05 degrees.

NOTE: At each beam position, in both the scan (cross track) and the spacecraft velocity (down track) directions, the beam pointing accuracy is defined as the difference between the intended and actual beam electrical boresight directions.

3.2.1.6.2
The beam scan angle of every beam position shall be digitized to 14-bit minimum accuracy.

3.2.1.6.3
The digitized beam scan angle position shall be multiplexed with the corresponding radiometric value.

3.2.1.6.4
The scan position digitizer used shall be designed to give position readout anywhere within the 360° rotation.

3.2.1.7 Beam Alignment

3.2.1.7.1
Not used.

3.2.1.7.2
The alignment of the JMS beam electrical boresight axes shall be measured with respect to an optical alignment cube.

3.2.1.7.3
Offsets of the optical alignment cube relative to the beam electrical boresight axes shall be known to better than $\pm 0.01^{o}$.

3.2.1.7.4
The optical alignment cube shall be visible on the nadir side and on the anti-sun side for verifying alignment on the spacecraft.

3.2.1.7.5
The optical cube(s) shall be permanently attached to the instrument and shall not interfere with the instrument operation.

3.2.1.7.6
The beam electrical axis, with respect to the instrument optical alignment cube and the instrument mounting surfaces, shall not be changed by more than $\pm 0.05°$ as a result of any testing.

3.2.2 ANTENNA SYSTEM

3.2.2.1 Beamwidth

3.2.2.1.1
The antenna beamwidth for each JMS channels shall be as defined in Table 3-1.

NOTE: Beamwidth is defined as the half-power points beamwidth (HPBW). The beamwidth in any plane containing the main beam axis (electrical boresight axis) shall be within plus or minus $\pm 10\%$ of the specified value. Beamwidth variation from channel to channel, having the same beamwidth, shall be smaller than 10% of the specified beamwidth value.

3.2.2.2 Not used

3.2.2.3 Polarization

3.2.2.3.1
Each JMS channel shall meet the quasi-polarization requirements as specified in Table 3-1.

NOTE: JMS quasi-horizontal and -vertical polarizations are defined by the following two equations:

$$\text{(1) Quasi Vertical Polarization (QV)} = T_V \cos^2\theta + T_H \sin^2\theta$$
$$\text{(2) Quasi Horizontal Polarization (QH)} = T_V \sin^2\theta + T_H \cos^2\theta$$

Notice that from equation (1) and (2), the QV and QH reduce to T_V (with electric field vector perpendicular to the orbital velocity direction) and T_H (with electric field parallel to the orbital velocity direction), respectively, at nadir when θ is zero degree. Here θ is the scan-angle (from nadir). T_V and T_H are the Brightness Temperatures of the Vertically polarized and Horizontally polarized components, respectively, following the conventional definition. (The Vertical polarization is the component whose electric field is lying in the plane of incidence, and the Horizontal polarization is the component whose electrical field is perpendicular to the plane of incidence.) In other words, the JMS receives a linear combination of the pure vertical and horizontal components. The total electric field vector of the received wave (either QV, or QH) is lying in a plane perpendicular to the propagation direction and making a polarization angle ϕ_p (in degrees), with respect to a reference (zero degree) line L, which is the intersection of the tangent (at beam center) plane and the plane of incidence. The total electric field vector rotates (i.e. the polarization angle changes) with the nadir angle θ equal to 0°. For Quasi Vertical, $\phi_p = \theta$. For Quasi Horizontal Polarization, $\phi_p = 90 - \theta$.

3.2.2.4 Beam Efficiency

3.2.2.4.1
The JMS antenna beam efficiency shall be 95% or better.

3.2.2.4.2
Beam efficiency shall be met at all frequencies and all beam positions.

NOTE: For the purpose of this specification, beam efficiency is defined as the ratio of the power received within the "main lobe" to that of the total power received by the antenna. The "main lobe" is defined as equal to 2.5 times the HPBW. In determining the beam efficiency, the antenna is assumed to be in a radiometrically isotropic environment, i.e., the brightness temperature is the same from every direction.

3.2.2.5 Center Frequency

3.2.2.5.1
Each JMS channel shall meet the center frequency requirements defined in Table 3-1.

3.2.2.6 Channel Bandwidth

3.2.2.6.1
Each JMS shall meet the Channel bandwidths defined in Table 3-1.

NOTE: Channel Bandwidths are defined as the half-power point bandwidth and are the maximum acceptable bandwidth per pass-band.

3.2.2.6.2
All channels, regardless of the number of pass-bands, shall have only one output per channel.

NOTE: The number of pass-bands listed in Table 3-1 is the maximum possible values. However, a lesser number of pass-bands can be used, provided the Temperature Sensitivity requirements are met. For example, Channel 18 lists two possible pass-bands which are centered at (183.31 + 7) = 190.31 GHz, and (183.31 – 7) = 176.31 GHz. But only one of the two pass-bands need be selected, provided the temperature sensitivity value of 0.8 K (or smaller value) can be achieved.

3.2.2.6.3
Each pass-band, within any one channel, shall have equal average system gain over the pass-band bandwidth within ±1 dB.

NOTE: System gain is the overall gain of the JMS system from the antenna aperture to the instrument output.

3.2.2.6.4 Pass-band Ripple
The peak-to-peak "ripples" within the pass-band bandwidth shall be less than 1.5 dB for at least 80 percent of the center portion of the pass-band bandwidth.

3.2.2.7 Out-of-Band Rejection

3.2.2.7.1
The channel selection filter shall have a gain that is a minimum of 40 dB below the band-center value for all frequencies outside of 0.65 times the specified half-power bandwidths.

3.2.2.8 Stop-bands

3.2.2.8.1

Receiver channel designs that use upper and lower mixer side-bands signals shall employ stop-bands to remove local oscillator noise.

3.2.2.8.2

Stop-bands may also be used to remove any Radio Frequency Interference (RFI) as required.

3.2.2.9 Gain Stability

3.2.2.9.1

The band center gain of each pass-band shall vary no more than ±2 dB over the operating temperature range and life of the instrument.

3.2.2.10 Center Frequency Stability

3.2.2.10.1

Each JMS Channel shall meet the center frequency stability values listed in Table 3-1.

NOTE: These values are the maximum deviation from the channel center frequency for both long-term and short-term periods. Long-term means that the stability must be maintained over the operational life of the instrument.

3.2.2.11 Temperature Sensitivity -- NEΔT

3.2.2.11.1

Each JMS Channel shall meet the Noise Equivalent Temperature (NEΔT) values listed in Table 3-1.

NOTE: Temperature sensitivity (NEΔT) of a radiometer is defined as the minimum detectable change of the brightness temperature incident at the antenna-collecting aperture. For the purpose of this specification, the NEΔT values listed in Table 3-1 shall be defined as the standard deviation of the radiometer output in Kelvin (K) when the antenna is viewing a 300 K uniform and stable target.

3.2.3 CALIBRATION

3.2.3.1 In-Flight Calibration

3.2.3.1.1

There shall be two types of in-flight calibration measurements during each scan period, a "hot" calibration and a "cold" calibration.

3.2.3.1.2

Each calibration measurement shall comprise a minimum of four sample periods.

3.2.3.1.3

Each sample period shall have an integration time equal to the earth view sample integration time.

3.2.3.1.4

All channels shall utilize a "through-the-antenna" calibration method whereby the calibration targets are viewed by the antenna main reflector.

3.2.3.1.5

The "cold" calibration target shall be the cosmic background microwave radiation (cold space).

3.2.3.1.6

At the cold calibration position, the antenna system shall have a clear unobstructed view of cold space.

The design of JMS shall ensure that the brightness temperature at the cold space calibration position is known with an error of 1 K or less. Accuracy of the measurement (measurement uncertainty) to 1 sigma.

3.2.3.1.7

The "hot" calibration target shall be an instrument ambient target (nominally 300 K).

3.2.3.1.8

The ”hot” calibration target shall be thermally isolated from the JMS structure.

3.2.3.1.9

A minimum of seven independent platinum wire-type temperature sensors shall be distributed through the target to ensure knowledge of the thermal temperature to ±0.10 K.

3.2.3.1.10

The brightness temperature of the target, at the relevant microwave frequencies of the JMS, shall be known to an accuracy of $\pm$0.2 K.

Note: This accuracy shall include the error in the knowledge of the thermal temperature of the target, residual temperature gradients across the target, and the uncertainty in the microwave emissivity.

3.2.3.1.11

The calibration targets shall achieve a calculated effective emissivity of 0.9990 or greater.

3.2.3.2 Calibration Accuracy

3.2.3.2.1

The JMS shall meet the calibration accuracies listed in Table 3-1.

NOTE: Calibration accuracy is defined as the difference (error) between the brightness temperature inferred from the microwave radiometer (referred to the antenna-collecting aperture) and the actual brightness temperature of a blackbody test target directly in front of the antenna. Calibration accuracy is the average long-term error with a time scale longer than 24 hours.

3.2.3.3 Analyses

3.2.3.3.1

The contractor shall demonstrate through laboratory testing and analyses that the overall calibration accuracy, when the instrument is used in its orbital configuration, meets the requirements of Table 3-1.

NOTE: The overall accuracy includes errors contained in the laboratory tests and other effects including:

(1) transition from the laboratory simulated cold space target to the in-orbit cold space target,

(2) emissions from the spacecraft and/or other instruments entering the near fields of the radiometer antennas,

(3) time dependent degradation of the reference targets,

(4) the error in the knowledge of the thermal temperature of the target, residual temperature gradients across the target, and the uncertainty in the microwave emissivity, and

(5) the accuracy of the test equipment.

3.2.3.4 Calibration Algorithm

3.2.3.4.1

Individual in-orbit antenna temperature calibration algorithms for each channel shall be provided for each delivered instrument.

3.2.3.5 Ground Calibration

3.2.3.5.1

The JMS shall be designed so that calibration is only performed once during initial qualification for each delivered instrument. No calibration shall be required after prolonged storage before launch.

3.2.3.6 Sensor Data Processing

3.2.3.6.1 Telemetry

All telemetry and mission data to be transferred to the spacecraft C&DH via the data bus shall be "packetized" using the Consultative Committee on Space Data Systems (CCSDS) Path Protocol Data Unit format defined in CCSDS 701.0-B-2.

3.2.3.6.2 SDR Content

The sensor contractor shall develop algorithms to produce sensor data records (SDRs). SDRs are full-resolution sensor data that are time-referenced, Earth-located, and calibrated by applying the ancillary information, including radiometric and geometric calibration coefficients and geo-referencing parameters such as platform ephemeris. These data are processed to sensor units (e.g., brightness temperature). Calibration, ephemeris, and any other ancillary data necessary to convert the sensor data back to sensor raw data (counts) are included.

The operational SDR shall, at a minimum, consist of the following S/C and JMS information:

- Spacecraft ID tag.
- JMS sensor ID or serial number.
- Flight software version number.
- Orbit number.
- Beginning Julian day and time tag
- Ending Julian day and time tag
- Ascending Node Julian day and time tag
- Brightness temperature in all channels
- Signal levels from all channels.
- Geo-location: geodetic latitude and longitude for each sample
- Time tag information - beginning of scan time
- Scan index

The contractor shall include in the development of the SDR additional algorithm processes that will:

- Combine the JMS 2.2 degree, over-sampled, IFOV's in a manner that combines the cross track and along track directions such that 15 area averaged samples are produced. Each sample shall be equivalent to that which would be obtained from a 3.3 degree IFOV, scanned at a constant rate, on each side of nadir. The Synthesized Cell #1 center shall be at 47.85 degrees from nadir. The brightness temperature for the synthesized footprint shall be the weighted average of averaged data samples.

- Combine JMS 5.2 degree, over-sampled, IFOV's in a manner that utilizes the cross track direction so that 15 area averaged samples are obtained. Each sample shall be equivalent to that which would be obtained from an IFOV scanned to produce beam centers separated by 3.3 degrees in cross track dimension and 3.3 degrees in along track dimension. The Synthesized Cell #1 center shall be at 47.85 degrees from nadir. The brightness temperature for the synthesized footprint shall be the weighted average of averaged data samples.

Consideration should be given to use of a process similar to that of Backus Gilbert, to enhance resolution, thus providing a synthesized IFOV of 3.3 degrees in both along track and cross track dimension.

3.2.4 SYSTEM DYNAMIC RANGE AND LINEARITY

3.2.4.1

The dynamic range of the radiometer system shall be from 3 to 330 K.

3.2.4.2

Within the dynamic range, the radiometer output shall be essentially linear with respect to the input brightness temperature at the antenna aperture.

3.2.4.3

The residual non-linearity at all points within the dynamic range shall be smaller than 10% of the calibration accuracy values listed in Table 3-1.

NOTE: residual non-linearity is defined as the departure from the expected value of an ideal linear radiometer.

3.2.5 ANALOG TO DIGITAL ELECTRONICS

3.2.5.1 General

3.2.5.1.1

The analog-to-digital (A/D) electronics shall consist of a multiplexer and 15-effective-bit A/D converter.

3.2.5.1.2

The allocations for the 15 bits vs. antenna brightness approximate temperature values are shown in Figure 3-2.

3.2.5.2 Multiplexer

3.2.5.2.1

The multiplexer shall not introduce a voltage offset or other errors sufficient to degrade the overall A/D conversion accuracy beyond 0.1% of full scale.

3.2.5.3 Analog-to-Digital Converter

3.2.5.3.1

The accuracy of the A/D converter at 15° C shall be plus or minus 1 Least Significant Bit (LSB) maximum allowable error.

3.2.5.3.2

The differential non-linearity (the bit-to-bit variation) shall not exceed plus or minus 1 bit.

3.2.5.3.3

Over the instrument mounting foot/baseplate temperature range of -10° C to +40° C the maximum allowable error shall not exceed ±1 LSB.

3.2.5.4 Independence of Measurements of Each Channel

3.2.5.4.1

The output signal presented to the A/D for each channel sample period shall be independent of past signals in that channel.

3.2.5.4.2

The A/D output of each channel sample period shall not be in error by more than 0.01% (of full scale) because of any previous signals in that channel or cross-talk from other channels.

3.2.6 Electronic Control Loop Stability

3.2.6.1

All closed-loop circuitry shall have a minimum of 12 dB gain margin and a 25 degrees phase margin.

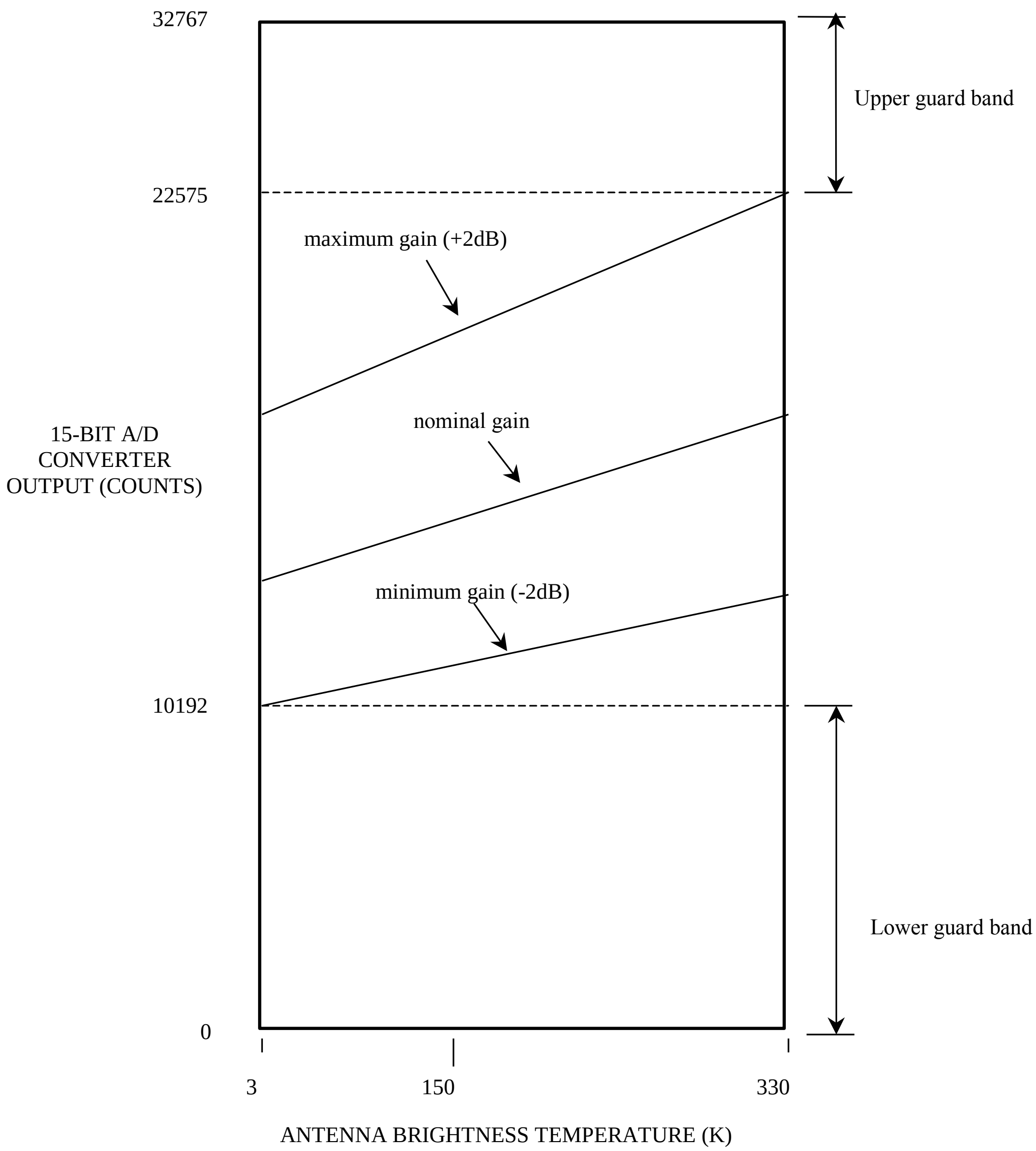

Figure 3-2 A/D Converter

3.3 INTERFACE REQUIREMENTS

The notional sensor interfaces are depicted in Figure 3-3.

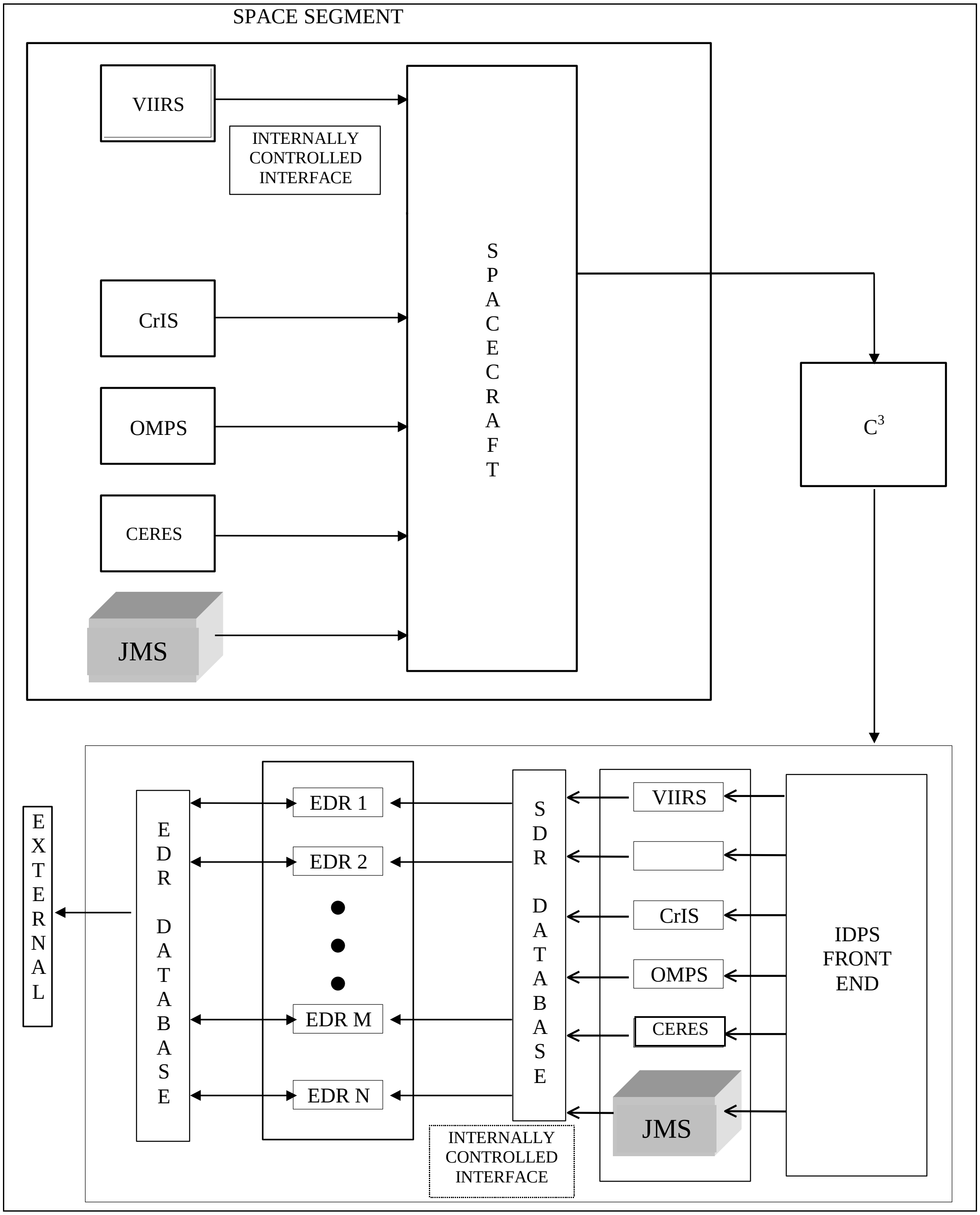

Figure 3-3 Sensor Interfaces on the JPSS Spacecraft

3.4 PHYSICAL AND INTERFACE CHARACTERISTICS

The mass, average power, volume, and data rate budgets for the JMS are provided herein. These values are the maximum allowed and include margin. The spacecraft-to-sensor interface requirements are broken down into four primary groups: mechanical, power, data, and thermal. A notional diagram of the top-level functional interfaces for any sensor is shown in Figure 3-4.

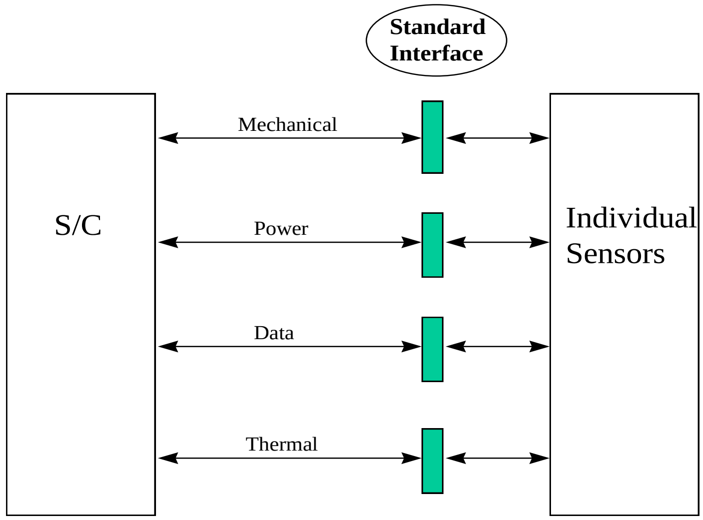

Figure 3-4 Notional Spacecraft-to-Sensor Functional Interfaces

3.4.1 MASS

The mass of the JMS shall be less than or equal to 85 kilograms.

3.4.2 SIZE

The stowed dimensions of JMS shall be less than or equal to the following limits:

(a) Velocity direction: 70 cm

(b) Nadir direction: 60 cm

(c) Anti-solar direction: 40 cm

3.4.3 POWER

The average steady-state power consumption for JMS shall be less than or equal to 130 Watts.

3.4.4 DATA RATE AND FORMAT

3.4.4.1 Data Rate

The science data rate of the JMS, at any moment in the orbit, shall be less than or equal to 50 kbps.

The house-keeping data rate of the JMS shall be less than 2 kbps.

3.4.4.2 Output Format

Instrument CCSDS output format shall contain spacecraft supplied data (i.e., ephemeris, time tag, etc.). This data shall be transferred via the MIL-STD-1553B data bus.

3.4.5 THERMAL

3.4.5.1 Blanketing

The thermal design of the JPSS instrument shall be configured as described in the JPSS GIID.

APPENDIX A. ACRONYMS AND ABREVIATIONS

Acronyms And Abbreviations

Acronym	***Definition***
A/D	Analog/Digital
AFM	Army Field Manual
AMSU	Advanced Microwave Sounding Unit
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
ASTM	American Society for Testing and Materials
C	Celsius
C&DH	Command and Data Handling
CCSDS	Consultative Committee on Space Data Systems
CDR	Critical Design Review
CDRL	Contract Documentation Requirements List
CF	Contractor's Facility
cm	centimeter
CMIS	Conical Microwave Imager Suite
CO	Contracting Officer
COTR	Contracting Officer's Technical Representative
CrIS	Cross Track Infrared Sounder
CSRD	Common Section of the Sensor Requirements Document
CTE	Calibration Test Equipment
DACA	Days After Contract Award
dB	Decibel
DC	Direct Current
ΔCDR	Delta Critical Design Review
DID	Data Items Description
DOC	Department of Commerce
DOD	Department of Defense
EDR	Environmental Data Records

Acronym	*Definition*
EDU	Engineering Development Unit
EEE	Electrical, Electronic, and Electro-mechanical
EM	Engineering Model
EMI	Electro-Magnetic Interference
EOS	Earth Observation System/Satellite
EWR	Eastern Western Range
EVS	Earned Value System
FED	Federal
FM	Flight Model
FMEA	Failure Modes Effect Analysis
FOV	Field of View
GB	Giga Byte
GFE	Government Furnished Equipment
GHB	Goddard Handbook
GHz	Gigahertz
GIID	General Instrument Interface Document
GPS	Global Positioning Satellite/System
GPSOS	Global Positioning Satellite Occultation Sensor
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
H_2O	Water
HDBK	Handbook
HPBW	Half-Power Beamwidth
Hz	Hertz
ICD	Interface Control Document
IDPS	Interface Data Processing Segment
IF	Intermediate Frequency
IORD	Integrated Operational Requirements Document
IRD	Interface Requirements Document
ISO	International Standards Organization
IV&V	Independent Verification and Validation
JMS	JPSS Microwave Sounder
JPSS	Joint Polar Satellite System
K	Kelvin
kbps	Kilobits per second
kg	Kilogram
km	Kilometer
LO	Local Oscillator
LSB	Least Significant Bit

Acronym	*Definition*
mb	Millibar
METOP	Meteorological Ops/EUMETSAT Meteorological Observation Satellite
MAR	Mission Assurance Requirements
METSAT	Meteorological Satellite
MHz	Megahertz
MIL	Military
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
mm	Millimeter
ms	Millisecond
NAS	National Aerospace Standard
NASA	National Aeronautics and Space Administration
NEΔT	Noise Equivalent Temperature
NOAA	National Oceanic and Atmospheric Administration
NPP	NPOESS Preparatory Project
NPPDIS	NPP Data and Information System
OMPS	Ozone Mapper Profiler Suite
PFM	Proto-Flight Model
PETR	Pre-Environmental Test Review
PLLO	Phase Lock Loop Oscillator
POS	Performance and Operations Specification
PPL	Preferred Parts List
QH	Quasi Horizontal
QV	Quasi Vertical
RDR	Raw Date Records
RF	Radio Frequency
RFI	Radio Frequency Interference
RH	Relative Humidity
S/C	Spacecraft
SDR	Sensor Data Records
SDS	Science Data Segment
SOCC	Satellite Operations Control Center
SOW	Statement of Work
Spec	Specification
SRD	Sensor Requirements Document
STE	Special Test Equipment

Acronym	*Definition*
SysTE	System Test Equipment
TBD	To be Determined
TBR	To be Resolved
TBS	To be Supplied
TIROS	Television Infrared Operational Satellite
TM	Technical Manual
TRD	Technical Requirements Document
TSPR	Total System Performance Responsibility
UIIS	Unique Instrument Interface Specification
VIIRS	Visible Infrared Imaging Radiometer Suite
W	Watts
WBS	Work Breakdown Structure
WR	Western Range

APPENDIX B. JOINT POLAR SATELLITE SYSTEM (JPSS) GENERAL INSTRUMENT INTERFACE DOCUMENT (GIID) (GSFC 472-00018 REV -, 12/15/2010)